Amendments to the Specification

Paragraph beginning at line 15 of page 1 has been amended as follows:

C3

Prior art efforts in parametric speaker applications have generally been limited to theoretical investigation of properties and applications. Commercial development of parametric products appear to have alluded the industry, based on lack of effective sound reproduction which is competitive with other conventional sound systems such as dynamic and electrostatic speaker systems. Even where a parametric speaker offers a distinct advantage such as with enhanced directionality, ~~commerical~~commercial success has been nominal.

Paragraph beginning at line 15 of page 1 has been amended as follows:

C4

Parametric speakers rely on effective coupling of ultrasonic sound output ~~of a unique nature~~ of a unique nature with surrounding air. Both theoretical and commercial product research has focused primarily on ~~the of~~ emitter devices that use piezoelectric bimorph structures, also known as piezoelectric benders. These devices use two layers of piezoelectric material that are bonded to each other and are driven out of phase. As one layer expands in length, the other contracts, providing output movement in a plane 90 degrees to the expansion/contraction direction. While the force of these devices is quite high the actual displacement and coupling to the air is rather poor. Therefore, successful performance of the bimorph relies on a second stage of conversion process in which the localized movements of the bimorph are amplified within the surrounding air. This is accomplished with various air matching means that consist of plate and disc structures that are comparable in size to a wavelength of the frequency of interest.

Paragraph beginning at line 17 of page 2 has been amended as follows:

C5

SUMMARY OF THE INVENTION

To a large extent, prior art efforts for enhancement of SPL ~~has~~ have focused on the multiplication of bimorph emitters, requiring ever increasing power demands. While it has been perceived that this can provide high ultrasonic output, the present inventors have discovered a number of limitations to this approach in terms of phase matching errors due to variations from device to device, distortion and bandwidth problems and the associated cost and complexity of

C5 cont

using so many separate devices. Indeed, the phase relationships of these separate devices are such that the total output of many devices used as a cluster does not add up to the amount predicted by just summing all the devices. This phase loss and lack of matching affects both output and directivity which can have many side lobes due to phase errors. In addition, it appears that these devices are also characterized by the fact that they tend to have many harmonic resonances and anti-resonances which are reflected in the demodulated audio of the parametric loudspeaker.

Paragraph beginning at line 1 of page 4 has been amended as follows:

C6

Such dynamic speakers are able to generate high levels of volume, particularly at low frequencies because of the strength of the drive system. They are also well suited for adaptation within small spaces, enabling use with speaker housings limited to small rooms, automobiles, etc. The versatility of dynamic speakers and their simplicity of operation as represented by the moving cone have favored a substantially uninterrupted lead position over any other type of audio reproduction system. Furthermore, such development has included expensive and complex audio control problems such as were enumerated in parent application 08/684,311-, incorporated herein by reference. Accordingly, complex equalizing and cross-over circuitry has been developed, as well as damping techniques to handle heavy weights of magnetic components of the dynamic speaker.

Paragraph beginning at line 10 of page 4 has been amended as follows:

C7

In contrast, the electrostatic speaker industry has offered significant potential for commercial benefit; however, because of size requirements and construction limitations, electrostatic speakers have failed to capture a significant market share--less than 5%. Therefore, despite certain advantages offered by electrostatic speakers over dynamic speakers within the audio industry, commercial and research focus continues to predominate on the dynamic form.

Paragraph beginning at line 15 of page 4 has been amended as follows:

It appears likely that this trend within the acoustic world has directly affected the direction research within the parametric field of sound reproduction. Specifically, virtually all development to date has been with the use of bimorph transducers, similar in construction to the dynamic speaker with its two stage operation. As noted above, bimorph systems have not realized the necessary results for commercialization of parametric speaker systems. Having failed to realize required levels of volume and quality with the "dynamic" form (bimorph transducer) of a ultrasonic emitter, there has been an apparent assumption by those skilled in the art that the lesser capable electrostatic or film-type emitter used for ultrasonic applications generally would be even less likely to perform in the parametric sound field. Therefore, those skilled in the art have apparently not considered the use of broad film diaphragms or single-stage electro-acoustical conversion systems as being likely to succeed with parametric sound. Surprisingly, the present inventors have discovered that a single-stage conversion process using such transducers as piezo and electrostatic films, etc., offer significant advantages which are unique to the parametric speaker industry.

C8

Paragraph beginning at line 2 of page 5 has been deleted:

~~Surprisingly, the present inventors have discovered that a single-stage conversion process using such transducers as electrostatic films, etc., offer significant advantages which are unique to the parametric speaker industry.~~

Paragraph beginning at line 5 of page 5 has been amended as follows:

(delete line)

(delete line)

(delete line)

(delete line)

~~OBJECTS OR SUMMARY OF THE INVENTION~~

C9

It is therefore an object of this invention to apply single-stage electro-acoustic technology to the parametric field of sound reproduction.

Paragraph beginning at line 1 of page 7 has been amended as follows:

C10

~~Figs. 1a and 1bd~~ Fig. 1d is a drawing of a film transducer of the invention driving the air in a homogenous fashion that distributes the drive and reduces shock.

Paragraph beginning at line 3 of page 7 has been amended as follows:

Fig. 1e is a drawing of a primary frequency waveform below shock level and at shock level.

C11

Fig. 2 is an orthogonal top view of a circular V grooved back plate for a large scale electrostatic film transducer.

Paragraph beginning at line 21 of page 7 has been amended as follows:

C12

Fig. 5a is a drawing of piezo film used in a ~~convex~~ concave dimpled form.

Paragraph beginning at line 22 of page 7 has been amended as follows:

C13

Fig. 5b is a drawing of piezo film used in a ~~concave~~ convex dimpled form.

Paragraph beginning at line 24 of page 7 has been amended as follows:

C14

Figs. 1a and 1b ~~is a~~ are drawings representing ~~a~~ prior art parametric loudspeakers 10 using multiple piezo bimorph transducers 11. These have been used with clusters of 500 to over 1500 bimorph transducers. One of the difficulties with parametric loudspeakers is that when driving the air at ultrasonic levels that provide reasonable conversion efficiency and loudness at the secondary

C14 Cont

resultant frequencies, the air can be driven into a shock limit where the fundamental frequency cannot get any louder and only distortion components are increasing in level. This shock limit is worse when driving individual, small points of air space. The more confined the intensity, the easier shock comes into ~~existance~~existence.

Paragraph beginning at line 8 of page 8 has been amended as follows:

C15

Fig. 1c is a drawing of a group of bimorph transducers each driving the air at small points in space 12 and causing shock. Fig. 1d is a drawing of a film transducer 13 of the invention driving the air in a homogenous fashion that distributes the drive 14 and reduces shock. A piece of piezoelectric film 18 is spaced from the electrically charged base 17 so that when a signal is applied to the base 17 a mechanical interaction is produced. Fig. 1e is a drawing of a primary frequency waveform below shock level 15 and at shock level 16.

One preferred embodiment of large scale film transducer is based on electrostatic drive principles. The electrostatic type transducer ~~is~~ uses a conductive backplate with a conductive film in close proximity to the backplate. A bias is applied to either the film or the backplate and both the film and the backplate are driven by two polarities of the drive signal. ~~Fig.2 is a and~~ Fig. 2a is a cross-sectional view of a large scale electrostatic film transducer -with a ~~21~~ circular V-grooved back plate 21. The back plate design may alternatively be pitted (concave) or dimpled (convex) in shape. When projecting high frequencies from large diaphragms compared to the wavelength of the frequency of interest the beam of sound can achieve such high directivity that the high frequencies will focus down to a tight beam.

Paragraph beginning at line 21 of page 8 has been amended as follows:

C16

The planar embodiment of Fig. 2 ~~This~~ can cause too high of directivity and also cause premature shock formation of the sound waves due to overly high intensities being focused in a small airspace.– By curving the diaphragm the radiation pattern can be opened up to have a directivity window comparable in width to the size of the transducer or even a somewhat wider spreading of sound to minimize shock limited waveforms. Fig. 2b shows an electrostatic film transducer with a curved backplate 23 and complementary shaped film diaphragm 22 that solves this problem.

Paragraph beginning at line 2 of page 9 has been amended as follows:

~~Fig. 2b shows an electrostatic film transducer with a curved backplate 23 and complimentary shaped film diaphragm 22 that solves this problem.~~ Another embodiment of the invention utilizes piezo electric film made of polyvinylidiene di-flouride (PVDF). This film expands and contracts when electrically excited and must therefore be deformed to achieve acoustic output. A preferred forming of the piezo film 30 into a rectified sine shape is shown in ~~figure~~ Fig. 3. Fig. 3a is a drawing of a rectified sine form of piezo film 30 with a quarter wave spaced backplate 31. By spacing the backplate 31 at a quarter wave length 35 from the film, the output of the emitter can increase up to 3 dB at the frequency whose wavelength is four times the distance from film to back plate. Fig. 3b is a drawing of a shallow rectified sine form of piezo film 32. Fig. 3c is a drawing of a shallow rectified sine form of piezo film 32 with back plate 31 spaced a quarter wavelength from the piezo film 32. Fig. 4 is a drawing of a sinusoidal shaped piezo film emitter 42. This form is efficient in utilizing all of the film as an emitter structure, except for tall sine shapes where the troughs 44 can be out of phase with the peaks 43. This is overcome by having the peak 43 to trough 44 distances equivalent to approximately one half wavelength ~~34~~. Fig. 4a is a drawing of a sinusoidal shaped piezo film 42 with spaced backplate 41. Fig. 4b is a drawing of a sinusoidal shaped piezo film 45 with a backplate 46 and a curvature 47 to open up the directivity angle of the primary frequencies to minimize shock formation and to open up the window of dispersion 48 as in the above mentioned electrostatic example.

C17

Paragraph beginning at line 18 of page 9 has been amended as follows:

C18

Most ultrasonic emitters and parametric loudspeakers are essentially monopole in radiation pattern. A parametric loudspeaker can be realized with the invention by using a open film 14

without a backplate ~~such as PVDF~~, ~~figure~~ as displayed in Fig. 4c, to radiate in a dipolar out-of-phase radiation pattern in the primary frequency range while simultaneously operating in a bipolar in-phase manner for all secondary parametrically derived signals. This could be used ~~where one wanted~~ to project highly directive, ~~in phase~~ in-phase sounds in two opposite directions. This is generally not practical to do with any prior art devices. ~~Fig. 4C is a drawing of a~~ This figure shows a sinusoidal shaped piezo film 41 used in dipolar primary frequency/bipolar secondary frequency mode. Another diaphragm form for piezo film is either a concave or convex dimpled structure. This shape may be achieved by thermo-forming the film or utilizing foam support structure to push the film into this shape. Fig. 5 is a drawing of piezo film 51 with a back plate 52 used in a concave or convex~~d impled~~ dimpled form ~~either concave or convex~~. The chambers 54 in the backplate 52 are pressurized with either positive or negative pressure to produce the concave or convex dimples. These chambers 54 can be pressurized separately or they may be part of a larger interconnected pressure chamber. Fig. 5a is a drawing of piezo film 51a used in a concave dimpled form ~~convex~~. Fig. 5b is a drawing of piezo film 51b used in a concave dimpled form ~~concave~~.

C18

Cont